

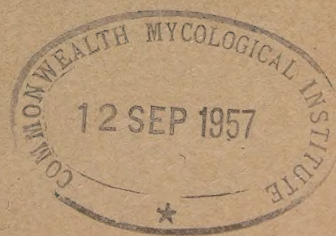
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ANNUAL REPORT

of the

WEST AFRICAN
RICE RESEARCH
STATION

1955



ADMINISTERING AUTHORITY

THE SIERRA LEONE GOVERNMENT

(*Director of Agriculture: T. N. GREEVES, B.SC., M.AGRIC.*)

SENIOR STAFF

At 31st December, 1955

Officer in Charge:

H. D. JORDAN, B.SC., A.R.C.S., A.I.C.T.A.

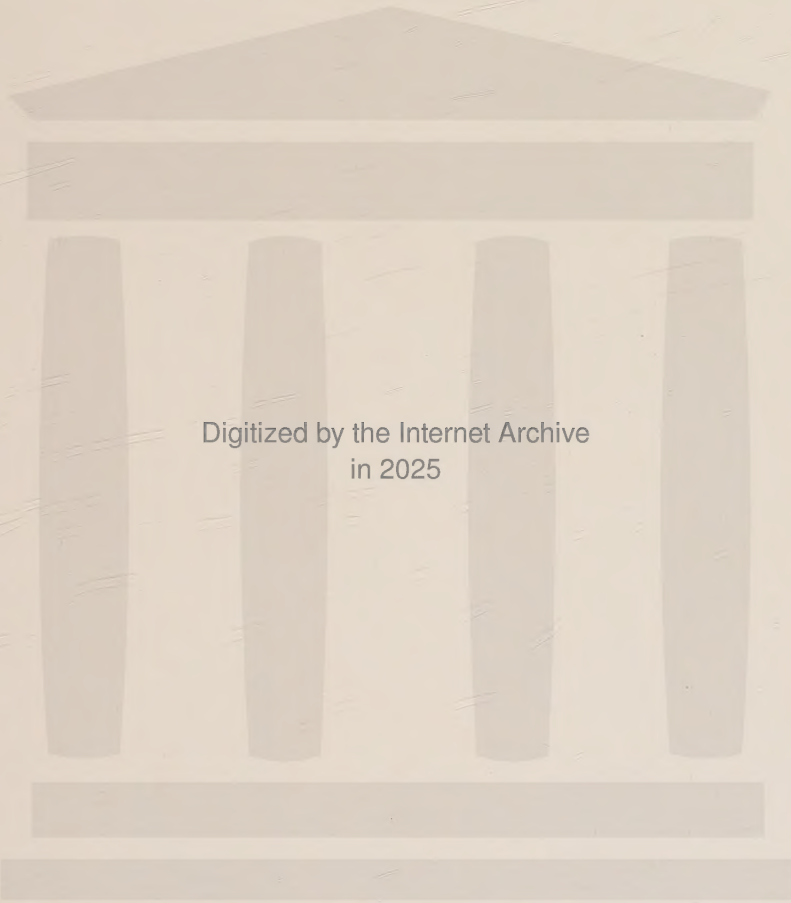
Botanists:

E. H. ROBERTS, B.SC., PH.D.

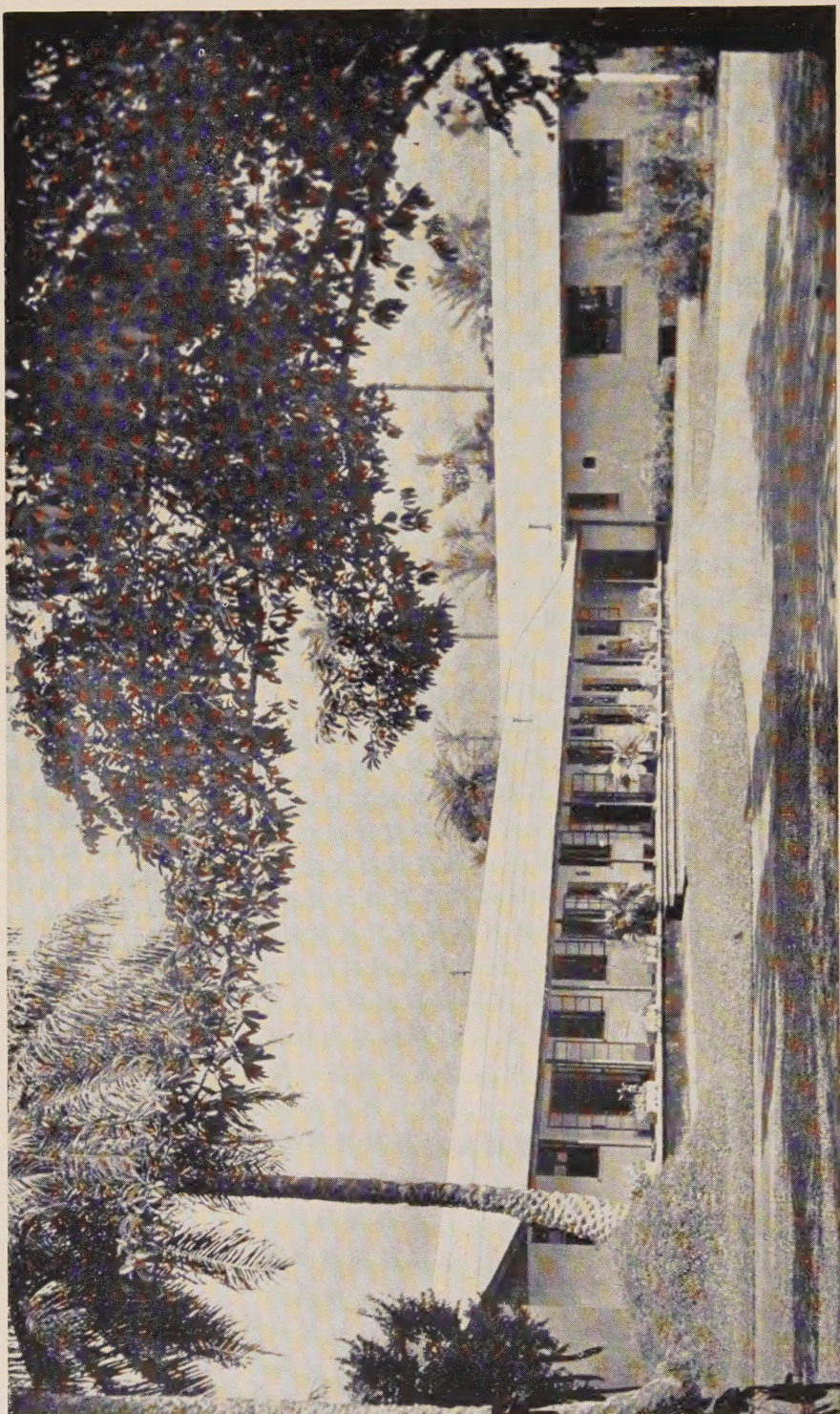
R. Q. CRAUFURD, B.SC.

Chemist:

T. E. TOMLINSON, B.A., D.PHIL., A.R.I.C.



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WEST AFRICAN RICE RESEARCH STATION
Administrative Wing of Main Building

ANNUAL REPORT
of the
WEST AFRICAN
RICE RESEARCH
STATION

1955

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INTRODUCTION

The year 1955 has seen considerable improvement in the setting up of the West African Rice Research Station at Rokupr and, at the end of the year, major construction was finished and there were only two vacancies in the approved establishment of research officers, though officers had been selected for these posts and were expected to arrive in 1956. It is thus now possible to look forward to an expansion of existing lines of research and the investigation of other problems, many of which have become apparent in the years since 1934. In this year a station was opened at Rokupr by the Sierra Leone Department of Agriculture for experimental work on rice in tidal mangrove areas on which the main development of swamp rice growing in Sierra Leone was being carried out. Early work was largely concerned with the determination of the best cultural practices and the improvement of yields by introduction and selection of rice varieties, and much valuable work was done despite staff limitations. As the development of swamp rice growing in Sierra Leone expanded, first to the sedge and grass swamps that lie between the mangrove and the upland and to the numerous inland valley swamps, and later by means of mechanization to the river flood plains of the central lowlands and southern coastal region, the work at Rokupr was extended to apply to these conditions as well as those of the mangrove swamps.

It was apparent in 1947 that rice growing was quite rapidly increasing in the other West African territories and proposals were put forward for the enlargement of Rokupr to serve the research needs for rice of all four countries. It was not until 1951, however, that funds became available for this, partly under the Colonial Development and Welfare Act and partly from the four territories concerned. Since that time the expansion of the station has proceeded gradually. It has not been possible up to the present to do much more than continue and consolidate existing lines of research owing to the staff position, but this aspect is expected to improve in 1956.

Under the present scheme the research needs of all four territories are considered at Rokupr. The administration of the station is carried out by the Sierra Leone Government through the Director of Agriculture, and the officer in charge of the station is a member of the Agricultural Department.

ADMINISTRATION

STAFF

Senior Staff

Mr. P. Adames, Principal Agricultural Officer, returned from leave at the end of January and resumed charge of the station from Mr. H. D. Jordan who left Rokupr at the end of February prior to proceeding on leave. Mr. Jordan returned to Rokupr at the end of July and, on the transfer of Mr. Adames to Departmental Agricultural headquarters in mid-August, took over as Officer-in-Charge. As no officer has yet been appointed for Agronomy and station management this work has devolved upon the Officer-in-Charge, but during the busy planting season in July

and August Mr. J. R. Wells, Temporary Agricultural Superintendent, was posted from the Department of Agriculture to assist, and the research staff undertook certain aspects of the work.

Dr. T. E. Tomlinson, Soil Chemist, returned from leave at the end of March. During his absence routine work in the laboratory had been carried out by Mr. R. D. J. M'Cauley, Temporary Laboratory Superintendent, but the continued absence of the second Chemist for which there is a vacancy, has meant that work is seriously curtailed during leave periods. Mr. M'Cauley's appointment terminated at the end of August and was not renewed, the training of laboratory staff for which the appointment was originally made being considered satisfactory.

Mr. W. Jackson, Botanist, resigned his appointment and left at the beginning of August. Fortunately there has been little interruption in the work as two new Botanists, Dr. E. H. Roberts and Mr. R. Q. Craufurd, were appointed and arrived in September and October respectively in time for the busy period when the rice is flowering and ripening and detailed recording is necessary.

Junior Staff

On the clerical side the position has not been very satisfactory largely owing to the lack of competent typists which has seriously hindered the publication of reports and bulletins.

Field staff have been sufficient for present needs, and the number of Laboratory Attendants has been increased to four, thus completing the establishment. It is more difficult however to obtain suitable candidates for the posts of Laboratory Assistant and only one has so far been appointed out of an establishment of three. An Agricultural Instructor of the Department of Agriculture is acting as a second Laboratory Assistant at present.

Unestablished staff and labour averaged 170 through the year.

Training of Junior Staff

A member of the Gambian Department of Agriculture arrived in May and spent the remainder of the year at Rokupr in order to familiarize himself with all the problems involved in rice growing and experimental work. A party of third-year students from the Sierra Leone Agricultural Training College spent a few days at Rokupr in June and three newly selected students spent the last half of the year doing their practical work at Rokupr.

PUBLICATIONS

Quarterly Progress Reports of a general and brief nature are issued in cyclostyled form for distribution to those most interested. The Annual Report for 1953 was printed and distributed and is the first Annual Report from the station to be published separately. The first of cyclostyled Periodic Scientific Reports was issued during the year and comprised a summary of results of a preliminary examination of soils from an empoldering scheme on saline mangrove land. Further work on these soils is being summarized in other Periodic Scientific Reports and will be published at a later date. These reports are produced for limited distribution and are in the form of interim reports summarizing aspects of work which are not complete enough for full publication.

A note on "Control of Crabs with crude B.H.C." by H. D. Jordan was published as a letter in *Nature*, Vol. 175, p. 734. A full paper on the subject is being submitted for publication shortly.

TOURING AND VISITS

The shortage of Senior Staff during most of the year has made it impossible for any visits to be paid to the other contributing territories, and made it difficult for more than the briefest visits to be made to Sierra Leone rice areas. However, a number of such visits have been made by members of the staff to the tidal mangrove areas of the Scarcies rivers, the empoldering schemes on saline land at Mapotolon near the French Guinea frontier and in the Colony, and to the central riverain flood plains.

VISITORS

There have been a considerable number of visitors to the station during the year, both from Sierra Leone and from overseas. In February and again in December His Excellency Sir Robert de Zouche Hall, K.C.M.G., Governor of Sierra Leone, honoured the station by official calls and on the latter occasion was able to pay a visit to the Mapotolon empoldering scheme, examination of the soils of which has formed an important part of the Soil Chemist's work.

The Honourable Bai Farima Tass II, Minister without Portfolio in the Sierra Leone Government, paid two brief visits to the station in February and July.

Visitors from the Colonial Office included Mr. G. W. Nye, C.M.G., O.B.E., Mr. W. B. L. Monson, C.M.G., Mr. R. J. Vile and Dr. C. F. Hickling, C.M.G. The latter was accompanied by Mr. A. G. Taylor, Director of the West African Fisheries Research Institute.

Mr. A. Pickles, Secretary for Agriculture and Forestry Research, West African Inter-Territorial Secretariat, visited the station for a few days in December, and Dr. J. G. Ossewaarde of the Netherlands Ministry of Agriculture, Mr. P. C. Isaacs of the University of Durham, and Mr. Lewis Grant of the firm of L. C. Grant, Ltd., Rice Mill Engineers also spent varying times at Rokupr during the year.

In January a party of five French Irrigation engineers, headed by M. Bauzil, Director of the Irrigation Services of Morocco, spent four days at Rokupr, and in November M. Salles, Director of Agriculture, French Guinea, and M. Moulon, Director of the Rice Research Station at Koba in French Guinea, paid a brief visit of two days accompanied by two soil chemists, M. Verot and M. Gras.

MANAGEMENT AND MAINTENANCE

BUILDINGS

No new construction was carried out during the year, the existing capital building scheme having been completed with the exception of six Junior Staff quarters and the alteration of one old existing semi-permanent Senior Service quarter. It has been decided however that this quarter is in such a bad condition that alterations and repairs would be uneconomic and that it will be preferable to demolish the building and construct a new house on the site, and it is hoped to do this in the coming year as well as to construct the junior staff quarters.

The electrical fitting of the laboratories having now been completed, the gas and vacuum services have been connected and put into use.

Minor repairs were carried out to buildings and two of the older Senior Service quarters were completely redecorated. The grass roofs of five old Junior Service quarters were replaced with corrugated iron sheeting. This completes the roof replacement programme with the exception of six small Farm Guards quarters.

SERVICES

The station water supply is provided by the damming of a small valley from which the water is pumped to a main storage tank. This latter is on the station grounds though the dam and pump house are not. Although the installation of this supply was carried out from the station's funds, the Sierra Leone Public Works Department is responsible for its running and maintenance, and the town of Rokupr is linked to the same supply. There was sufficient water for all purposes throughout the year.

In a similar manner the electricity supply, though entirely on the station, is run and maintained by the Sierra Leone Electricity Department. During the year wiring was carried out in Rokupr town and this will be linked with the supply, provision having been made in the power house for the installation of two extra generating sets from Sierra Leone funds. Supply was maintained satisfactorily throughout the year, though there have been minor voltage fluctuations for the reduction of which a phase balancer is to be installed.

VEHICLES AND MACHINERY

The Commer van became unserviceable during the year and was replaced by a 3-ton Bedford lorry which has sufficed for station haulage and for general road transport. It is apparent that a lighter type of vehicle in addition to this would be of use for touring by the research officers and for light local transport and it is hoped to obtain a Landrover at a later date.

River transport has continued to consist of a diesel launch and a T 20 runabout launch, though the former was out of action for part of the year awaiting a new stern tube and rudder. A Seagull outboard engine and locally made boat are available for minor river transport.

An M.G.6 tractor with mounted ploughs was obtained to supplement the M.G.5 tractor and implements for farm cultivation and a Hayter motor scythe and two small motor lawn mowers to supplement the Allen Autoscythe and large motor lawn mower for station upkeep. Hand mowers were also used for the smaller areas of lawn.

Maintenance and minor repair of all machinery have been carried out in the station workshops with advice and assistance when required from a Mechanical Superintendent of the Department of Agriculture.

STATION UPKEEP

General repairs have been carried out to all station roads and the approach and forecourt of the offices and laboratories have been completely remade and tarred.

A considerable area of the upland on which the quarters and laboratories are situated is laid out as a lawn and this mown area is being increased annually as, when once the grass has been cut short and forms a turf, upkeep is easy.

One of the areas used for rice nurseries has been relaid out in order to make better use of the land available, and minor repairs to bunds, drains and bridges on the swamp farm have been carried out.

MISCELLANEOUS CROPS AND STOCK

Crops

Cassava has been planted on a few odd pieces of land at the edge of the swamp and has given a constant supply of bait for trapping crabs in connection with investigations on their control.

A supply of vegetables has been maintained through the year and a number of new varieties tested and reports sent to the Horticulturist, Department of Agriculture.

A small plantation of Angola Oil Palms was established on the station a number of years ago and fruit from these palms is collected regularly as a seed supply for Agricultural Department extension work. An Oil Palm nursery established at Rokupr in connection with this was closed during the year when the work was transferred elsewhere.

A good supply of fruit for staff use has been available and a number of young trees have been planted at the newer houses.

Livestock

The herd of Ndama cattle has been maintained and at the end of the year there were 30 animals. Eight calves were born during the year and four animals were slaughtered. Manure from the cattle was used in the vegetable garden and combined with compost applied to the rice nurseries.

One boar and one sow are kept and two litters of piglets were obtained during the year. Seven animals were sold and slaughtered and at the end of the year there were nine animals fattening.

There are still a few ducks on the station, though the numbers have been drastically reduced by sale and it is not proposed to increase the stock of these again. They were originally obtained for trials in controlling the numbers of crabs on the farm.

WEATHER

The total rainfall for the year was above average and the rainy season began early and finished late, more rain being recorded in March and April than in these months in the last twenty years, and December rainfall being much higher than usual, though a few days of strong harmattan in this month brought exceptionally low afternoon humidities. Full meteorological records for Rokupr for the year are given in Table 1.

AGRONOMY

No changes were made in the standard nursery and planting practices which have been adopted as the result of experiments in past years and to which brief reference was made in the 1953 report. Spraying bunds and drains with a suspension of technical benzene hexachloride was carried out as a routine measure prior to planting and greatly reduced damage from crabs was recorded.

TABLE 1

Meteorological Records Rokupr—1955

	<i>Jan.</i>	<i>Feb.</i>	<i>March</i>	<i>April</i>	<i>May</i>	<i>June</i>	<i>July</i>	<i>Aug.</i>	<i>Sept.</i>	<i>Oct.</i>	<i>Nov.</i>	<i>Dec.</i>	<i>Year</i>
Rainfall (20 year average)	0.05 (0.13)	0.00 (0.05)	2.33 (0.42)	7.81 (1.86)	8.37 (6.80)	12.46 (14.18)	24.36 (23.23)	36.30 (29.38)	16.77 (18.00)	12.67 (15.09)	6.14 (5.52)	2.23 (0.66)	129.49 (115.82)
Sunshine (15 year average)	257.1 (251.0)	247.6 (228.8)	254.0 (241.3)	208.7 (203.7)	172.7 (193.5)	140.7 (160.0)	106.7 (105.9)	73.6 (63.3)	110.7 (128.0)	184.4 (189.0)	230.4 (199.5)	209.3 (224.4)	2195.9 (2196.2)
Mean Maximum Temperature (15 year average)	90.7 (91.1)	91.6 (93.0)	91.5 (93.3)	90.3 (92.9)	88.7 (91.0)	85.4 (88.2)	83.0 (84.3)	81.8 (81.8)	84.7 (85.4)	87.1 (88.4)	88.9 (89.0)	87.2 (89.5)	87.6 (89.0)
Absolute Maximum Temperature (15 year record)	97 (102)	94 (101)	96 (102)	94 (103)	94 (101)	91 (99)	88 (98)	87 (91)	89 (99)	91 (96)	91 (96)	90 (97)	97 (103)
Mean Minimum Temperature (10 year average)	69.7 (68.1)	70.0 (69.5)	72.0 (71.9)	72.8 (73.5)	72.3 (73.7)	71.4 (72.9)	71.4 (72.4)	71.4 (72.5)	72.7 (72.5)	71.3 (71.9)	71.3 (72.0)	67.1 (69.2)	71.1 (71.7)
Absolute Minimum Temperature (10 year record)	62 (55)	62 (60)	69 (66)	70 (69)	70 (69)	63 (63)	68 (60)	69 (68)	69 (68)	68 (68)	67 (63)	56 (53)	56 (53)
Mean Relative Humidity a.m. (11 year average)	89.5 (87)	86.8 (87)	84.4 (82)	88.2 (79)	88.0 (83)	90.0 (89)	90.0 (93)	90.6 (95)	90.9 (93)	87.0 (91)	87.0 (91)	87.1 (88)	88.3 (88)
Maximum Relative Humidity a.m. (11 year record)	100 (100)	100 (100)	95 (100)	96 (100)	100 (100)	100 (100)	95 (100)	100 (100)	95 (100)	95 (100)	100 (100)	95 (100)	100 (100)
Mean Relative Humidity p.m. (11 year average)	52.8 (48)	51.4 (49)	55.9 (51)	89.1 (55)	75.0 (62)	75.9 (73)	81.3 (80)	86.6 (85)	80.5 (78)	74.8 (75)	66.0 (68)	51.9 (58)	70.1 (65)
Minimum Relative Humidity p.m. (11 year record)	20 (12)	27 (15)	42 (19)	60 (28)	52 (34)	59 (44)	65 (54)	70 (54)	65 (51)	56 (57)	54 (37)	10 (10)	10 (10)

Rainfall in inches. Sunshine in hours. Temperature in degrees Fahrenheit. Relative Humidity as percentages. Morning readings taken at 09.00 hours. Afternoon readings taken at 15.00 hours. Bracketed figures are averages and records.

TABLE 2
Yields of multiplication blocks—1955
(in lbs. paddy per acre)

<i>Block</i>	1949	1950	1951	1952	1953	1954	1955
1	970	3,250	1,760	—	1,060	1,050	2,060
2	510	2,270	1,730	1,840	870	—	1,630
7	2,220	480	2,200	2,370	1,580	1,740	1,740
10	2,030	1,740	970	2,650	1,170	2,200	1,870
13	2,630	2,680	960	2,540	460	2,140	1,820
14	1,640	2,670	1,000	2,480	1,760	1,640	1,280
16	2,490	2,030	440	2,360	—	—	1,760
17	2,870	3,520	580	1,760	—	—	1,410
20	2,700	1,900	340	2,840	910	—	1,040
28	1,940	1,710	1,660	1,520	860	2,220	2,100
30	—	—	610	1,600	840	650	1,170
31	810	1,680	1,830	1,170	—	1,510	2,600
32	160	930	600	500	1,930	530	1,330
33	900	840	1,540	1,210	—	—	1,770
34	1,290	800	780	1,970	1,170	700	2,060
35	1,040	1,070	1,360	1,320	—	1,770	1,640
36	1,590	790	910	1,460	440	550	2,090
37	960	1,440	1,100	1,150	1,150	1,560	1,330
38	—	—	780	1,190	470	760	1,570
39	530	1,260	660	1,010	860	960	1,170
40	—	—	130	660	310	460	1,640
41	1,320	1,750	1,350	1,720	1,210	1,400	1,290
42	—	—	980	1,370	810	1,320	1,860
43	1,500	2,580	2,210	2,440	1,090	2,280	2,260
44	950	1,170	1,430	1,420	950	—	2,540
45	750	1,530	1,140	1,670	1,000	1,540	2,570
46	—	—	610	1,380	800	1,990	2,410
47	—	—	1,100	910	360	770	1,380
48	—	—	1,130	1,270	380	450	1,140
49	—	—	880	910	370	860	890
50	2,200	2,970	2,530	520	1,370	2,290	1,310
51	1,280	1,980	1,360	1,280	1,860	2,400	2,950
52	990	870	1,160	2,430	1,160	2,180	2,370
53	950	1,320	1,190	1,590	1,550	1,640	1,140
54	740	1,210	1,130	1,820	650	1,220	2,210
55	—	—	1,080	1,650	590	870	830
56	—	—	880	690	670	540	620

Note.—Blocks 1 and 2 had heavy fertilizer application in 1950.

Blocks 10, 13 and 14 were water controlled in 1950 and 1951.

In 1951 and in 1953 crabs caused considerable damage.

Weather conditions were favourable to growth and, in general, yields were good. Table 2 shows yields of blocks that were in use for multiplication of seed rice as compared with yields in the last six years. On the section of the farm on the other side of the river yields were poor as early varieties were planted and suffered badly from bird damage.

874 bushels (of 60 lbs. weight) of seed were produced and the purity of this was maintained at a high standard. This amount was made up of the following varieties:—

D 99	112 bushels
B.G. 79	70 "
Lead	56 "
Sughandi	25 "
Bolo 108	121 "
Ngasein 57	178 "
Toma 112	129 "
India pa lil 46	99 "
Kavunginpoothala 12	84 "

Most of this seed was disposed of to farmers by the Sierra Leone Department of Agriculture, and one bushel each of D 99 and B.G. 79 was sent to the Gold Coast Department of Agriculture for their further multiplication.

CRAB INVESTIGATIONS

Daily collections of crabs were continued and the complete year's figures examined. It was found that in the rainy season the numbers of crabs caught in traps became less, which is probably due to the more abundant food supply, and that fewer of the females caught were carrying eggs. Correlations were found in the dry season between the percentage of females with eggs and the states of the tide. In the period from neap tide to neap tide through high spring tide more females were carrying eggs than in the period neap tide to neap tide through low spring tide. These percentages are shown in Table 3 and there is high significance between those for high and low spring tides in the dry season and between the figures for dry and wet season at all states of the tide, but no significance between high and low spring tide percentages in the wet season.

TABLE 3
Females with eggs as percentages of total females caught

<i>Time of Year</i>	<i>High Spring Tides</i>	<i>Low Spring Tides</i>	<i>All Tides</i>
Dry Season	26.9	13.1	19.4
Wet Season	5.4	4.6	5.0
All Seasons	16.2	10.6	13.7

It was also found that males always outnumbered females and that in the dry season a higher percentage of females were caught at low spring tides. It is thought that female crabs carrying eggs may tend to retire into their holes and not feed so frequently and that this may account for the observed facts.

Pure gamma benzene hexachloride (BHC) was tested in the laboratory as a contact poison and found to be effective against crabs and slightly quicker acting than technical BHC in the form used. Its use on a field scale would give little advantage and routine spraying with the technical product is therefore being continued.

Experiments have shown that treatment of seedlings in the nursery a few days before transplanting with technical BHC at rates of half an ounce per square yard and more is likely to make the seedlings less liable to attack by crabs after transplanting, and this is now being adopted as a routine measure for hybrids and selections which are usually planted out as single plants. The results of a controlled experiment in which 32 seedlings were subjected to attack by crabs in the presence of an alternative food supply are shown in Table 4.

TABLE 4
Crab damage to rice seedlings treated with BHC

<i>Treatment</i>	<i>Per cent seedlings destroyed</i>
1 oz. Agrocide per square yard	17.5
$\frac{3}{4}$ " " " " "	16.3
$\frac{1}{2}$ " " " " "	16.9
$\frac{1}{4}$ " " " " "	28.8
0 " " " " "	31.3
Critical Difference	10.6

Practical methods of controlling crab attack on rice seedlings having been found, the investigation is ceasing for the present and full details are being prepared for publication.

ARBORICIDE TRIALS

Trials were continued by the Agricultural Officer at Bonthe on the effect of chemical weedkillers on *Rhizophora* mangrove and a summary of this work is given.

Observations were continued on the trees treated in the 1954 experiment in which various dilutions in diesel oil of 2,4-dichlorophenoxyacetic acid (2,4-D), 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), 2-methyl, 4-chlorophenoxyacetic acid (MCPA) as butyl esters and ammonium sulphamate were applied with and without slashing of the trees. Application was by brush to the bark and the slashed trees had three cuts made prior to treatment. Considerable defoliation had taken place by the end of 1954 and further observations in 1955 showed that very few of these defoliated trees recovered. From the results of this experiment, which are shown in Table 5, it is seen that, with the exception of ammonium sulphamate and 2,4,5-T in its form of Trioxone A on unslashed trees, all chemical treatments appeared equally effective in killing the mangrove, and that ring barking alone has had considerable effect.

TABLE 5
Effect of treatments on *Rhizophora* mangrove, 1954

Treatment	Concen- tration	No. of trees treated		No. of Defoliated and apparently dead trees			
	per cent	3/3	20/4	30/6	31/8	21/12	10/7/55
(a) Slashed							
2,4-D	20	10		7	8	9	10
2,4-D	25		5	0	5	5	5
2,4-D	30		5	1	5	5	5
2,4,5-T	25		5	0	3	3	5
Trioxone A	25		5	0	4	3	4
Trioxone B	20		5	1	4	4	5
MCPA	20		5	0	4	5	5
MCPA	10		5	0	0	4	5
Am. sulphamate		10		0	0	0	0
Control		10		0	0	0	0
(b) Unslashed							
2,4-D	25		5	1	5	5	5
2,4-D	30		5	1	4	4	5
2,4,5-T	25		5	0	5	5	5
Trioxone A	25		5	0	2	0	0
Trioxone B	20		5	0	4	5	5
MCPA	20		5	1	2	5	5
(c) Ring barked		10		0	0	6	7

On the results of this experiment it was decided to lay down a more precise experiment in 1955 in which lower concentrations of the effective chemicals would be used in order to determine whether lower rates of application would cause death to *Rhizophora* mangrove.

2,4-D, 2,4,5-T and MCPA were used in varying concentrations in diesel oil and one-fifth of a pint was applied per tree. Some trees were again slashed and some not slashed. In addition ammonium sulphamate in concentrated solution was applied in holes bored into trees. Apart

from the ammonium sulphamate, all treatments proved effective and it is apparent that more dilute solutions of these chemicals can be used. Details of this experiment are given in Table 6.

TABLE 6
Effect of treatments on Rhizophora mangrove, 1955

Treatment	Concen- tration	No. of trees treated	No. of Defoliated and apparently dead trees		
	per cent	14/3/55	10/7	31/8	25/11
(a) Slashed					
2,4-D	4	5	1	3	4
2,4-D	8	5	1	4	4
2,4-D	12	5	5	5	5
2,4-D	16	5	3	3	4
2,4-D	20	5	5	5	5
2,4,5-T	4	5	3	4	4
2,4,5-T	8	5	4	4	5
2,4,5-T	12	5	3	5	5
2,4,5-T	16	5	2	2	5
2,4,5-T	20	5	2	4	4
MCPA	8	5	3	4	4
MCPA	12	5	3	5	5
MCPA	16	5	0	4	4
(b) Unslashed					
2,4-D	4	5	3	3	5
2,4-D	8	5	3	5	5
2,4-D	12	5	5	5	5
2,4-D	16	5	3	5	5
2,4-D	20	5	5	5	5
2,4,5-T	4	5	1	3	4
2,4,5-T	8	5	0	4	4
2,4,5-T	12	5	4	4	5
2,4,5-T	16	5	1	4	5
2,4,5-T	20	5	3	4	4
MCPA	8	5	3	5	5
MCPA	12	5	4	4	4
MCPA	16	5	4	4	4
(c) Am. sulphamate		5	0	0	0

The preliminary work having now been completed it is intended to carry out more detailed work from the Rice Research Station on the minimum concentrations which will be effective.

ESTIMATION OF YIELDS

The Sierra Leone Department of Agriculture requires a simple method of obtaining an approximate estimate of yields of rice on areas being newly developed under mechanization. At their request a simple sampling technique was tested at Rokupr, where accurate yields of the farm blocks are recorded.

In the past a half-acre block of rice was harvested as one-square-yard plots and from the yield figures it was calculated that the optimum size of samples was four square yards and that for a single estimate to give a figure for yield within ten per cent of the true yield twelve such samples would be needed. Such sampling would be impracticable at present on a large scale and it was thought that for an estimate of the average yield

of a large area fewer and smaller samples from each separate farm might suffice. Proper randomization of these samples would also be impracticable in the field with the existing organization and a standard instruction for the taking of four one-square-yard samples from each block was therefore issued.

On farmers' land it would be unsatisfactory to remove the rice from the sample areas for drying and weighing and it would be more convenient if it could be measured on the spot. The volume of the rice at harvest from each sample was therefore measured and comparison made of this with the weight after drying. It was found from this that, although the ratio of volume to weight varied slightly with variety, the approximation of 10 ccs. equivalent to 60 lbs. paddy per acre (1 Sierra Leone bushel per acre) could be used and the error so caused was well within the error of sampling.

As expected the sampling method showed considerable bias, though the Standard Error was in general lower than had been anticipated, and estimated yield was considerably greater than true yield. A line of regression of estimated yield on true yield has been fitted and it may be possible by the use of this to correct means of estimated yields to mean true yield.

Eye estimation was also carried out on the farm blocks by four observers and their eye estimates calibrated by fitting lines of regression of estimated on true yield. This method with trained observers proved relatively more efficient than the sampling method.

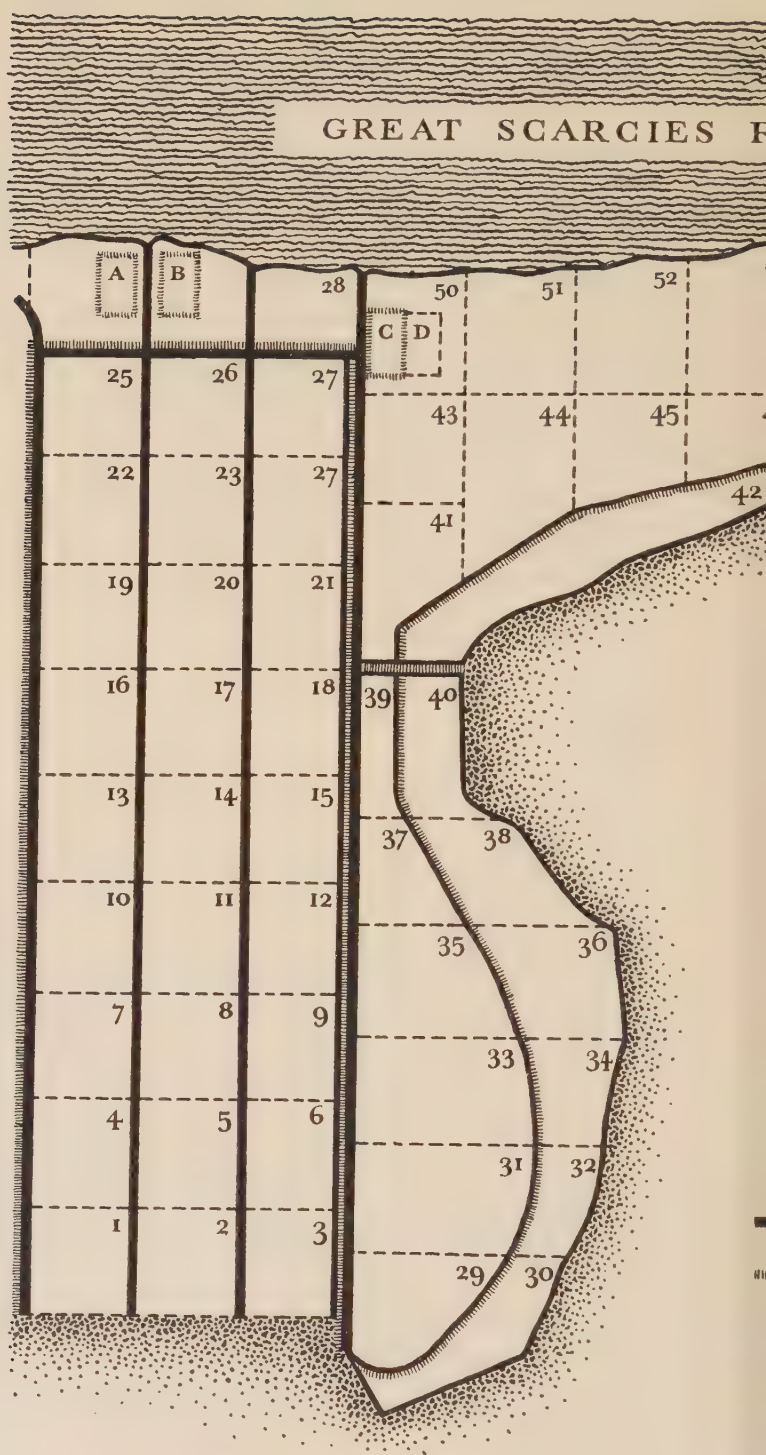
It is proposed to test both these methods by estimating 1956 yields by them, adjusting the estimates by the 1955 calibrations and comparing with true yields.

UNIFORMITY TRIAL

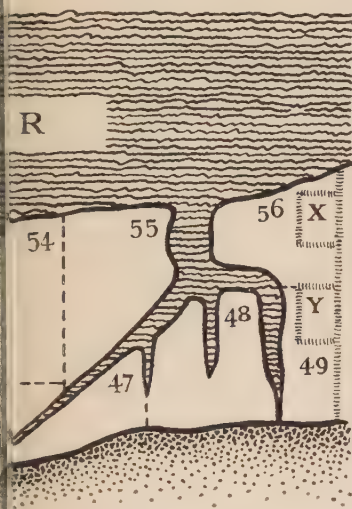
Lack of uniformity has been a source of trouble on the tidal mangrove land at Rokupr and in the past statistical yield trials with different varieties and uniformity trials have shown a high Coefficient of Variation and differences in yield of less than 10 per cent between varieties have not been apparent. It has been considered that a modification of the size and shape of plots might help in reducing the Coefficient of Variation and a uniformity trial was thus laid down in an endeavour to obtain preliminary information on this. The design of this experiment was taken from a paper by Murray in Trinidad (*Tropical Agriculture*, **27**, 105, 1950) and 48 plots arranged in eight rows of six each, size 15 feet by 13 feet were pegged on the most uniform part of the farm and planted with the variety Lead. These plots were separately harvested and by combining the yield figures in various groups statistical analyses were carried out in a number of ways, both as randomized block experiments with four blocks running at right angles to the main drain and as randomized block experiments with three blocks running parallel to the main drain. Results are given in Table 7 and indicate that on this piece of land randomized block experiments laid down with long narrow plots of one-fortieth to one-sixtieth of an acre running parallel to the main drain and with blocks arranged in the same direction are likely to give the most satisfactory results.

Using the 36 centre plots of this trial, further analyses were carried out on a latin square basis, both with single plots arranged 6×6 and groups of four plots arranged 3×3 . Results are given in Table 8 and show that by arranging experiments on a latin square layout further improvement can be obtained.

ROKUPR FARM



PLANTING PLAN 1955



<i>Block</i>	<i>Variety</i>
1	D 99
2	D 99
3	Hybrids
4	Selections
5	Selections
6	Hybrids and Experiments
7	Sughandi
8	D 99, Kav. 12 and Lead
9	Collection
10	Sughandi
11	Toma 112
12	Collection
13	Kav. 12
14	Bolo 108 and Indo-China 53
15	Collection
16	Indo-China 53
17	Uniformity Trial and Indo-China 53
18	Collection
19	Promising Varieties
20	Promising Varieties
21	Collection
22	Promising Varieties
23	Promising Varieties
24	Collection
25	Promising Varieties
26	Promising Varieties
27	Uniformity Trial and B.G. 79
28	India pa lil 46
29	Genetic Stocks and B.G. 79
30	Kav. 12
31	Yield Trial, B.G. 79 and Experiments
32	Kav. 12
33	Yield Trial and B.G. 79
34	Kav. 12
35	B.G. 79
36	Kav. 12
37	B.G. 79
38	Kav. 12
39	B.G. 79
40	(Nurseries)
41	B.G. 79
42	B.G. 79
43	B.G. 79
44	Lead
45	Lead
46	Lead
47	Lead
48	Lead
49	Lead
50	India pa lil 46
51	D 99
52	D 99
53	D 99
54	D 99
55	Lead
56	Lead
A	Sughandi
B	Sughandi
C	Sughandi
D	Sughandi
X	Sughandi
Y	Sughandi

DRAINS

BUNDS

TABLE 7
Analysis on randomized block layout

Plot			C.V.	No. of replications required to show differences of 10 per cent between Means
Size	Units	Area		
Four blocks				
15 ft. × 13 ft.	1 × 1	1/223	18.39	25
15 ft. × 26 ft.	2 × 1	1/112	17.14	23
15 ft. × 39 ft.	3 × 1	1/74	15.27	19
30 ft. × 26 ft.	2 × 2	1/56	14.43	18
30 ft. × 39 ft.	2 × 3	1/37	12.45	14
15 ft. × 78 ft.	6 × 1	1/37	13.59	16
Three blocks				
30 ft. × 26 ft.	2 × 2	1/56	23.53	43
60 ft. × 13 ft.	4 × 1	1/56	6.04	5
60 ft. × 26 ft.	4 × 2	1/38	6.05	5
120 ft. × 13 ft.	8 × 1	1/38	3.26	3

TABLE 8
Analysis on latin square layout

Plot			C.V.	No. of replications required to show differences of 10 per cent between Means
Size	Units	Area		
15 ft. × 13 ft.	1 × 1	1/223	11.75	13
30 ft. × 26 ft.	2 × 2	1/56	5.13	4

The plots have been left pegged and a yield trial will be planted on some of them next year, the remainder being used for a further uniformity trial. It is hoped to see whether the pattern of fertility remains constant and if so whether an analysis of covariance technique will give better results in the analysis of comparative yield trials.

An adjacent multiplication block was pegged prior to harvest and the crop harvested separately from a number of plots and similar analyses made. The Coefficients of Variation were greater than in the experiment reported above. These plots have also been left pegged and a uniformity trial will be placed on them next year.

BOTANICAL RESEARCH

INTRODUCTION AND TESTING OF RICE VARIETIES

Only a few new introductions were made during the year. Kahogo and Afaa Mwanza were reintroduced from Tanganyika together with Sifara, which had not been introduced before. Two Turkish varieties, Akceltik and Sarakilcik were also received. Only small quantities of seed of these rices arrived and their potentialities could not therefore be judged this year.

There were 347 rices grown in the collection, 28 of which were local upland varieties, 118 local swamp varieties including selections and 201 introduced varieties and selections from them. These rices were grown in small plots as usual to maintain the strains and for observation. With

the increase in staff it has now been possible to carry out much more detailed examination of these rices than in the past and a close examination of their characters has been started. These characters fall into two groups; characters useful for identification purposes such as the pigmentation of various parts of the plant, and characters of agricultural importance such as tillering capacity, disease resistance and straw strength, a sound knowledge of which is essential as a basis for the future selection and breeding programme. It is intended to record these characters for each variety by means of a punched card system of classification.

Thirty-one rices introduced in recent years, and which appear particularly promising, were grown in plots of one-tenth of an acre at Rokupr to observe their behaviour under conditions more nearly approximating to normal field conditions on tidal mangrove land, and in particular to obtain a better idea of their yielding capacity. In most cases the yields maintained their earlier promise, though eleven of the rices suffered badly from lodging. It is possible however that this was partly due to the intensive roguing that was carried out and they will be grown again next year in different shaped plots to minimize the necessity of walking about in the plots during roguing. Plots of these rices were also grown for observation by Agricultural Officers in the southern mangrove area and on the central riverain flood plains. Flood caused considerable damage to some varieties but several very good yields were obtained and from these and the previous year's results it is becoming possible to group the varieties for yield, both on mangrove land and on riverain grass lands.

Samples of a number of rice varieties were sent on request to other countries, both within and outside West Africa, and a list of these is given in the appendix.

SELECTION OF IMPROVED RICES

New Selections

As selections made previously from the Ceylon rice Kurulutuduwi b13 had proved still to be genetically impure after several years they were bulked and sown in a single plot and 54 single panicle selections were made from this as the start of a new series. This rice is a good yielding long duration rice but suffers from susceptibility to *Piricularia oryzae* and it is hoped to select out a more resistant strain.

First Year Selections

The selections of the varieties resistant to submergence Kema and Lath which were made in the field last year, on the central riverain flood plains, were examined in the laboratory and a number discarded on undesirable grain characters. Thirty-nine and 20 strains respectively were retained and planted out in rows of single plants. Germination of Kema was poor and eight strains failed to grow. The remaining 31 thrived but the numbers of plants were insufficient for detailed recording of characters and only general observations were made. The strains of Lath were examined for purity by recording of flowering behaviour and tiller counts were also made. Four were discarded as a result of field observations and 16 retained for further work.

Second Year Selections

After laboratory examination and discarding, 20 strains of the local floating rice Mbagboli remained and these were planted out as single plants in rows. Staking of the plants made the recording of characters easier and flowering records and tiller counts were made as a result of which one strain was discarded and 19 harvested for future work.

The 22 strains of D 99 from last year were reduced in the laboratory in a similar way to 13 and five further discarded after field observations. Eight thus remain for next year's planting.

Fifth Year Selections

Although no significance was shown in last year's yield trial it was decided to discard two of the G.E.B.24 selections and only two remain. These were further put into a statistical yield trial in comparison with unselected seed. Yields varied from 1,470 to 1,600 lbs. per acre with G.E.B.24/37 again giving the best yield, but no significance was shown. This rice, which was popular in the past, is not now widely grown as it is susceptible to *Piricularia oryzae* in the nursery, but in one or two places it is still preferred to other varieties and can give good yields.

Sixth Year Selections

Three further Lead strains were discarded and the remaining five planted this year. Only general observations were carried out and the strains are being maintained for testing of milling quality.

Three of the B.G.79 selections from last year's trials were discarded and the remaining four again put into a statistical yield trial in comparison with the unselected variety on saline land at Maswari in the Colony. Soil samples were taken from all plots shortly after transplanting and the chloride content found to vary from 900 to 2,000 parts per million of wet soil. Acidity of the soil varied between pH 6.3 and pH 7.0. All the rice failed, presumably due to too high a level of salinity.

Seventh Year Selections

The eight strains of Sughandi were further reduced by the discarding of two after laboratory examination and the remaining six were put into a statistical yield trial in comparison with the unselected variety and two new introductions of it from Burma. Yields varied from 1,300 to 1,680 lbs. per acre but no significance was shown between them. These six strains were also planted in rows of single plants and flowering records and tiller counts made. It was decided on the result of the observations to discard three strains, and three therefore remain for milling tests.

Three strains of the local rice Kalimodu were discarded on laboratory examination and the remaining four planted as single plants in rows. One was further discarded as a result of field observations and the remaining three retained for milling tests.

Older Selections

A number of strains of older selections are still being retained for milling tests which will be starting shortly. A few of the strains grown last year were discarded after examination of characters in the laboratory and a review of their field behaviour and those remaining were grown this year and are as follows:—

Toma (local)	14 strains
India pa lil (local)	10 „
Pokkali (ex Ceylon)	3 „
Kavunginpoothala (ex Madras)	4 „
Indo-China (ex French Sudan)	4 „
Ngasein (ex Burma)	3 „

HYBRIDIZATION

The mass selections of the 1951 hybrids made last year were sown in the F4 generation and planted out as single plants. Further mass selection was made at harvest from two series of crosses, Toma 112 × Ngasein 57

and India pa lil 46 $\times$ Kav. 12 and the seed kept for 1956 sowing. Single panicle selections were made from the other two crosses, 40 from DC 39 $\times$ Yenti and 20 from Ngasein 57 $\times$ Tai Chu, and these will be grown in 1956 as separate cultures. This has been done in order to obtain experience of handling material in this way, the practical problems involved and the value of the method compared with mass selection and bulking for a number of generations.

The F2 seed of the Indo-China 24 $\times$ Indo-China 53 cross made in 1953 was sown and the seedlings planted singly in rows. Mass selection was made at harvest.

Last year's crosses between Lead and B.G.79 and Lead and D 99 were sown in the F1 generation in pots. All seedlings exhibited anthocyanin pigmentation which is thus presumably a dominant character in these crosses. The seedlings were not grown to maturity.

No further crosses were attempted, as it is considered that further hybridization should wait until recording of the characters of rices in the collection is complete.

MAINTENANCE OF GENETIC PURITY

Seven single plant cultures from the bagged plants of 1954 were planted as single plants and three plants of each were bagged prior to flowering and harvested separately. One bagged plant from each of the seven varieties was selected for next year's single plant cultures and the remainder bulked as a nucleus stock for multiplication.

DISEASES

Piricularia oryzae and *Helminthosporium oryzae* were common on the nurseries, but neither caused any serious damage this year.

Ephelis pallida again occurred in the field but only on a few panicles. No rices previously attacked by this fungus were attacked this year and it was only recorded on four varieties, Berekute, Tuiboi, Wong Huk Chai and Serendah Menangkabau, on none of which it has previously been found.

One panicle of Kav. 12 was found attacked by *Ustilaginoidea virens*.

COLLECTIONS

As the collection of algae from the rice farm has been carried out for several years and the specimens sent to Bangor for identification, it was decided in August that no further purpose would be served by continuing and collection ceased.

A few more collections of phanerogams and ferns have been made for the herbarium, and herbarium specimens of the rice varieties in the collection have been taken to supplement the grain samples already kept.

CHEMICAL RESEARCH

In many mangrove areas, where there are no large rivers to maintain fresh water conditions during the rainy season, the salt concentration of the tidal water is too high for rice growing and salt water must be excluded and fresh water admitted if the land is to be used for this purpose. In practice this usually entails empoldering the land and holding rain water in the growing season. Experience has however shown that some mangrove soils, which are high in sulphides, undergo chemical changes characterized by an increase in acidity when they are allowed to dry out—and that conditions inimical to the growth of rice develop. The work of the Soil Chemist has therefore been concentrated on the study of

the changes which occur in such soils on drying and their effect on the growth of rice, as an understanding of the precise causes of rice failure in acid soils is necessary before techniques for soil amelioration can be developed.

It should be stressed that this extreme acidity only occurs in certain mangrove soils and that even in these it does not normally occur under natural conditions. Where tidal irrigation is with fresh water during the growing season rice growth is perfectly satisfactory, but where tide water is always saline and empoldering is essential the recognition and understanding of changes in such soils due to seasonal drying is of great importance in their development for rice growing.

ROKUPR EXPERIMENTAL POLDERS

An empoldering experiment was begun in 1946 to investigate the effect of tidal influence on the fertility of sulphide-containing mangrove soils. Four small polders have been subjected to different tidal conditions. The tide is excluded from Polder A for the six months of the wet season (June to December), from Polder B during the dry season (December to June), totally from Polder C and is admitted at all times to Area D. Rice growth has been satisfactory in A, B and D but rice has failed completely in C.

The acidity of the surface soil in each of the plots has been determined at monthly intervals since 1953 and a marked seasonal fluctuation demonstrated. Acidity increases in all four plots in the dry season and decreases in the wet season, the actual values of pH ranging from 7.0 to 4.0-4.5 in A, B and D and from 5.5-6.0 to 2.5-3.0 in D.

In July 1955 the experiment was extended and monthly determinations of surface soil acidity were made at five other sites on Rokupr farm, none of which had carried mangrove before clearing. No regular fluctuations have been observed.

Soil samples from the experimental polders were examined at monthly intervals from May 1955, and fluctuations of the levels of various ions extracted with normal ammonium acetate solution were determined. Chloride was determined in aqueous extract.

The levels of phosphate (total), iron, and aluminium depend upon acidity, except that the level of iron in C is fairly constant. In all other cases the level of iron and aluminium is much reduced at pH values above about 5.5 and the phosphate level above a value of 4.5-5.0.

The level of chloride falls during the wet season, the only unexpected feature being that the dry season level is higher in the two plots from which the tide is excluded than in those to which the tide is admitted at this time of the year. This may be due to seepage of saline water under the bunds and concentration of salt inside the plots.

The levels of calcium in A and B only and the levels of magnesium and potassium in all polders rise at the beginning of the wet season and subsequently fall. The rise of calcium level, which occurs in July, is most marked but the rises in magnesium and potassium levels are less pronounced and occur a month later. The reasons for the rises in the levels of these ions were not investigated but decomposition of plant residues prior to planting of rice may be of importance. The subsequent fall of the calcium level is more pronounced than that of either of the other ions, no calcium being detectable in the extract of any soil sample collected after August.

No fluctuation in the level of manganese was observed.

If the fluctuations in acidity observed are general in this type of soil they are obviously of great practical importance. The survival of transplanted rice seedlings in marginal areas may depend critically on the

time of planting. In addition these fluctuations may seriously complicate soil studies, particularly the use of soil analyses for fertilizer advisory purposes, as the levels of availability of some ions depend upon acidity and thus upon the time of sampling of the soil.

Investigation of the cause of this seasonal fluctuation of acidity has only been recently begun. Present indications are that water movement in the soil profile is responsible, the acid compounds being leached from the surface horizons during the wet season, and returning to the surface due to upward water movement during the dry season. Alternatively, since the occurrence of acidity has been shown to be related to soil aeration, and the surface of some soils tends to dry during the dry season, even under tidal conditions, the precursors of the acidic compounds may be transported upwards in the reduced form and oxidised at the surface.

MAPOTOLON EMPOLDERING SCHEME

A second survey of the empoldering scheme at Mapotolon was made. This scheme consists of two independent polders, each of an area of 250 acres, one of which (Polder A) was completed in 1951/2 and the other (Polder B) in 1952/3. The polders have perimeter drains and are surrounded by bunds four to five feet high. There were two principal objects in this year's work: firstly to continue and extend the survey begun in 1954, since the changes with time of the soils enclosed in the scheme are of interest; and secondly to obtain correlations between acidity, original vegetation, levels of availability of certain ions in the soil and rice failure. It was hoped that as a result it might be possible to state whether soils are suitable for empoldering and also to obtain some indication of the ions responsible for the failure of rice.

The soil samples were collected at the end of April, 1955 using a modification of the method used in 1954. Samples of surface soil were collected at specific points instead of an attempt being made to obtain samples which are representative of the surface soils of five-acre farming plots. The modification necessitated the collection of a greater number of samples but even so the sampling density is less than one per acre. Soil profiles were not examined as a number of representative ones had been studied in 1954.

The soil samples were stored in air-tight bottles and their acidity determined within six days. Ninety-six samples were selected for further examination on the basis of acidity and geographical distribution. The following analyses were made: moisture content and loss on ignition; chloride in aqueous extract; and calcium, magnesium, iron, aluminium, manganese and phosphate in normal ammonium acetate extract.

There was a good correlation between acidity of the soil and the type of original vegetation growing on it—much better than was found in 1954 using the different sampling technique. High soil acidity was, in general, associated with areas known to have borne *Rhizophora racemosa*, except in a strip running south to east across Polder B which had acid soil and where the vegetation prior to empoldering consisted of other types of mangrove. This strip had a soil which was rich in organic matter and rather fibrous in texture, a condition usually associated with *Rhizophora racemosa*, and may possibly have borne this mangrove at an earlier date. The present correlation is therefore better stated as between high acidity and fibrous soils. These soils are usually confined to the lower areas; there is thus also a good correlation between surface acidity and elevation. Low acidity is associated with areas of high relief, village sites and areas formerly used for salt collection. It is probable that the association of acidity with relief depends upon the necessity of permanently waterlogged

conditions for the accumulation of sulphides, but the greater variation of salinity expected in higher areas may be of importance if the reduction which leads to sulphide accumulation is bacteriological.

Although the highest available iron levels were not in the regions of highest acidity there was a close correspondence between high iron, high aluminium and high acidity. High exchangeable manganese was also associated with high acidity but only occurred in areas where the level of organic matter was relatively low. All three ions are probably present in toxic amounts in some areas.

There was a close correspondence between chloride and magnesium levels indicating that they are both determined by the same factors, though the ratio of chloride to magnesium in the soil is less than in sea water. Presumably, both depend upon the availability and concentration of saline ground water, magnesium being retained in the soil to a somewhat greater extent than chloride, possibly on account of base exchange. In contrast, the levels of exchangeable calcium showed no correlation with those of exchangeable magnesium or chloride. Coupled with the fact that the ratio of calcium to chloride is generally much greater than that found in sea water, it appears that sea water is not the principal immediate source of calcium, which may be retained in vegetation and sea shells.

The level of phosphate was the only one studied which indicated a possible nutrient deficiency, but there are no data relating to crop responses to phosphate fertilization on soils which have been extracted using this method so that the evidence is inconclusive. The distribution of phosphate is such that the higher the soil acidity the greater the amount of phosphate available to extraction with ammonium acetate at equal acidity to the soil.

Approximately 40 per cent of Polder A and 30 per cent of Polder B have suffered an increase in acidity since 1954. However, except for the belt of soils in Polder B to which reference has been made and in which the change seems to be a genuine trend, it is not possible to say with certainty whether the changes represent a trend or result from a large annual fluctuation of soil acidity of the type reported in the previous section. The level of chloride in both polders was less than that recorded in 1954, although that in Polder A was still generally less than that in Polder B. A detailed comparison of the levels in 1954 and 1955 show that the changes are consistent with the theory that chloride is slowly being leached from the polders.

The empoldering scheme was visited again at the beginning of December 1955, when the growth of rice was recorded. It was found that the area of rice planted was much more extensive than in 1954, 70 as opposed to 25 per cent in Polder A and 55 as opposed to 20 per cent in Polder B. Twenty per cent of A and five per cent of B were waterlogged.

The correlation between the results of soil analysis and the growth of rice, although much better than in 1954, was still poor. Thus, although with two exceptions—one probably due to the flood of toxic drainage water and the other probably an instance of rice failure due to high salinity—all areas where rice failed had pH values below 3.5 in April, the converse statement does not hold.

The best correlations with rice growth (apart from that with acidity) were with chloride and aluminium levels, but both of these were open to some objection. In the case of the former not many areas of high April chloride content were planted with rice, and in the case of the latter some areas which had a high April aluminium content were anomalous in growing rice. It is rather surprising for there to be a true correlation between April chloride content and rice growth, for the chloride levels in the polders must fall substantially in the early part of the rainy season

(in April they were mostly too high for rice growth to be possible) and there seems no reason why the pattern of the distribution should not change during this fall.

The lack of good correlation between the results of analysis and rice growth is no doubt due to a number of factors, the more important of which are probably seasonal fluctuations in acidity, the use of different rice varieties and planting times and experimental errors. The results obtained do not make it possible to state which ion is responsible for rice failure, although aluminium is indicated.

RICE GROWTH AT VARYING LEVELS OF ACIDITY

As observation on the soils of the Mapotolon empoldering scheme gave so little indication of either the tolerance of the rice plant to acidity or the cause of death of rice seedlings in acid soils, a pot experiment was designed to obtain this information. Seedlings of the rice variety Lead were transplanted at the age of 28 days into samples of a sulphidic mangrove soil which had been allowed to dry for different periods of time. As the acidity of such soils rises rapidly on drying it was possible in this way to obtain a series of soils covering the range pH 6.5 to pH 2.5 in which the different levels of acidity were the principal causes of difference in properties. The growth of the seedlings was compared with that of seedlings in soils of different acidity and that of seedlings transplanted into samples of fresh mangrove soil. Samples of the soils used were examined in the laboratory where the acidity and the contents of calcium, magnesium, iron, aluminium, manganese and phosphate in extracts with ammonium acetate (at equal acidity to the soil) were determined.

It was found that the growth of seedlings which were transplanted into soils with pH values greater than 5.0 was indistinguishable from that of seedlings transplanted into fresh soils with pH values between 6.4 and 7.0. Below pH 5.0 however tillering was restricted and the older leaves of the seedlings died back from their tips. As the acidity increased these effects became more pronounced and at about pH 4.0 some seedlings of each batch died. Below pH 3.0 all the rice seedlings died on transplanting. It was not possible to obtain the threshold pH values with precision since the acidity of the soils changed a little during the experiment.

The rice plants were uprooted at the age of 80 days and the above- and below-ground parts dried separately and weighed. There was a marked decrease in the weights of both roots and shoots of plants grown in soil below pH 5.0.

The soil samples were examined in the laboratory and it was found that changes in the levels of calcium, magnesium and manganese were small. The levels of aluminium and iron increased rapidly and markedly however over the range of acidity in which the growth of rice was restricted. The level of aluminium began to increase at a somewhat higher pH value than that of iron, pH 5.5 as opposed to pH 5.0, but it was not possible to determine whether both or only one of the ions was the toxic agent. The amount of phosphate extracted was also found to increase as acidity rose, the increase beginning at the same pH value as that at which the level of exchangeable iron begins to increase and suggests that the phosphate which becomes available with increasing acidity is associated with iron.

The rate of change on drying of some of the properties of the soil used was investigated in a preliminary experiment. It was found that the pH values fell from 6.84 to 2.48 in 23 days. The fall of sulphide content was even more rapid from 900 parts per million oven dry soil to 200 during the first day and to zero after 12 days. The increase in sulphate level was slower and did not appear to be complete after 32 days, when the level had risen from 400 to 15,000 parts per million. These rates of change are similar to those reported to occur during the drying of Swedish gyttja soils.

H. D. JORDAN,

Officer-in-Charge.

APPENDIX

RICES SENT OVERSEAS—1955

To Northern Rhodesia

Indo-China 24	...	...	...	local selection, floating
Indo-China 53	...	...	...	local selection, floating
Indo-China 70	...	...	...	local selection, floating
Mbagboli	...	...	...	local, floating
Ngala wai	...	...	...	local, floating

To the Netherlands

Indo-China 70	...	...	...	local selection, floating
Toma 112	...	...	...	local selection
Bolo 108	...	...	...	local selection
India pa lil 46	...	...	...	local selection
Ngasein 57	...	...	...	local selection
Kema	...	...	...	local, resistant to submergence
Mbagboli	...	...	...	local, floating
D 99	...	...	...	ex British Guiana
Lead	...	...	...	ex British Guiana
Sughandi	...	...	...	ex Burma

To the Gold Coast

Yenti 38	...	...	...	local selection
D.C. Upland	...	...	...	local, upland
Boguti	...	...	...	local, upland
D 99	...	...	...	ex British Guiana
B.G. 79	...	...	...	ex British Guiana
Kuk Chai	...	...	...	ex Hong Kong
Wong Chim	...	...	...	ex Hong Kong
Wong Huk Chai Mei	...	...	...	ex Hong Kong
Pusur	...	...	...	ex East Pakistan
Siam 8	...	...	...	ex Orissa

To the University of the Gold Coast

D.C. 39/15	...	...	...	local selection
Yenti 38	...	...	...	local selection
Toma 112	...	...	...	local selection
Ngasein 57	...	...	...	local selection
Bolo 108	...	...	...	local selection
India pa lil 46	...	...	...	local selection
Kavunginpoothala 12	...	...	...	local selection
Kogbandi	...	...	...	local, upland
Gbengbete	...	...	...	local, upland
Ngalawa	...	...	...	local, upland
Faya	...	...	...	ex Nyasaland
G.E.B. 24	...	...	...	ex Madras
MLY B 404	...	...	...	ex Burma
MLY C 401	...	...	...	ex Burma
Tjina	...	...	...	ex Indonesia (via Gambia)
Radin China 4	...	...	...	ex Malaya
Mayang Ebos 80	...	...	...	ex Malaya
Mayang sa gumpal	...	...	...	ex Malaya
Raminad	...	...	...	ex Phillipines
Elon Elon	...	...	...	ex Phillipines
2/16	...	...	...	ex Tanganyika
B.G. 79	...	...	...	ex British Guiana
Lead	...	...	...	ex British Guiana

APPENDIX—*continued*

RICES SENT OVERSEAS—1955

To Eastern Nigeria

S R 26	...	...	...	...	ex Ceylon
Raminad Str. 3	...	...	...	...	ex Phillipines

To British Guiana

Toma 112	...	...	...	...	local selection
Bolo 108	...	...	...	...	local selection
Indo-China 24	...	...	...	...	local selection, floating
Indo-China 53	...	...	...	...	local selection, floating
Mbagboli	...	...	...	...	local, floating
Sughandi	...	...	...	...	ex Burma

To the Argentine

Yenti 38	...	...	...	...	local selection
Toma 112	...	...	...	...	local selection
Bolo 108	...	...	...	...	local selection
India pa lil 46	...	...	...	...	local selection
Kema	...	...	...	...	local, resistant to submergence

To the United States of America

Ngasein 57	...	...	...	...	local selection
Toma 112	...	...	...	...	local selection
Bolo 108	...	...	...	...	local selection
India pa lil 46	...	...	...	...	local selection
Kavunginpoothala 12	...	...	...	...	local selection
Indo-China 53	...	...	...	...	local selection, floating
Kema	...	...	...	...	local, resistant to submergence
Lead	...	...	...	...	ex British Guiana
D 99	...	...	...	...	ex British Guiana
B.G. 79	...	...	...	...	ex British Guiana
G.E.B. 24	...	...	...	...	ex Madras
Sughandi	...	...	...	...	ex Burma

To the Rice Research Station, Badeggi, Nigeria

Indo-China 24 and 53	...	...	...	...	local selections, floating
G.E.B. 24/20 and /37	...	...	...	...	local selections
B.G. 79/2, /3, /16 and /22	...	...	...	...	local selections
Lead 20, 35, 43, 44 and 46	...	...	...	...	local selections
India pa lil 12, 46 and 82	...	...	...	...	local selections
D.C. 39/15	...	...	...	...	local selection
Toma 112	...	...	...	...	local selection
Bolo 108	...	...	...	...	local selection
Kalimodu 60	...	...	...	...	local selection
Mbagboli	...	...	...	...	local, floating
Vohgbati	...	...	...	...	local
Tisei	...	...	...	...	local
D 85/42	...	...	...	...	ex British Guiana
D 54/42	...	...	...	...	ex British Guiana
H R 35	...	...	...	...	ex Hyderabad
Ptb. 15	...	...	...	...	ex Madras
Ptb. 16	...	...	...	...	ex Madras
1/18	...	...	...	...	ex Tanganyika
2/16	...	...	...	...	ex Tanganyika
Dharial	...	...	...	...	ex East Pakistan
Patnai	...	...	...	...	ex East Pakistan

APPENDIX—continued

RICES SENT OVERSEAS—1955

J 7	...	...	...	...	ex Orissa
Sc 308/51	...	...	...	...	ex Orissa
Wag Wag	...	...	...	...	ex Phillipines
Ramai	...	...	...	...	ex Phillipines
Gantang	...	...	...	...	ex North Borneo
Baak	...	...	...	...	ex Indonesia (via Gambia)
Pokkali	...	...	...	...	ex Ceylon
Siam 9	...	...	...	...	ex Orissa
Siam 29	...	...	...	...	ex Malaya
Anak Ikan Rendah	...	...	...	...	ex Malaya
Anak Didek	...	...	...	...	ex Malaya
Nachin 11	...	...	...	...	ex Malaya
Radin China 4	...	...	...	...	ex Malaya
Tai Chu 65	...	...	...	...	ex Malaya
Kontor	...	...	...	...	ex Malaya
MYA B 103	...	...	...	...	ex Burma
HM C 17	...	...	...	...	ex Burma
HM C 19	...	...	...	...	ex Burma
A 29-20	...	...	...	...	ex Burma
C 15-10	...	...	...	...	ex Burma
C 24-102	...	...	...	...	ex Burma
Faya	...	...	...	...	ex Nyasaland

To Kenya

Indo-China 24	...	...	...	local selection, floating
Kavunginpoothala 12	...	...	...	local selection
Bolo 108	...	...	...	local selection
Toma 112	...	...	...	local selection
D.C. 39/15	...	...	...	local selection
Yenti 38	...	...	...	local selection
Kalimodu 60	...	...	...	local selection
Ngasein 57	...	...	...	local selection
India pa lil 46	...	...	...	local selection
Kema	...	...	...	local, resistant to submergence
Mbagboli	...	...	...	local, floating
Lead	...	...	...	ex British Guiana
D 99	...	...	...	ex British Guiana
B.G. 79	...	...	...	ex British Guiana
G.E.B. 24	...	...	...	ex Madras
Haji Harun	...	...	...	ex Malaya
Radin Siak 34	...	...	...	ex Malaya
Acheh Puteh	...	...	...	ex Malaya
Radin China 4	...	...	...	ex Malaya
Milek Kuning 3	...	...	...	ex Malaya
Relong Telor	...	...	...	ex Malaya
Kontor	...	...	...	ex Malaya
C 28-15	...	...	...	ex Burma
C 24-102	...	...	...	ex Burma
MLY B 404	...	...	...	ex Burma
Sughandi	...	...	...	ex Burma
H R 38	...	...	...	ex Hyderabad
Elon Elon	...	...	...	ex Phillipines
Ramai	...	...	...	ex Phillipines
Raminad	...	...	...	ex Phillipines
Patnai	...	...	...	ex East Pakistan
Kow Pa	...	...	...	ex Thailand
Parn	...	...	...	ex Thailand
Pai Gazo	...	...	...	ex North Borneo
Gantang	...	...	...	ex North Borneo
Faya	...	...	...	ex Nyasaland
Pokkali	...	...	...	ex Ceylon
Kurulutuduwi b13	...	...	...	ex Ceylon
Boa Vista	...	...	...	ex Peru
Siam 9	...	...	...	ex Orissa

APPENDIX—continued

RICES SENT OVERSEAS—1955

To East Bengal

Bolo 108	...	...	...	...	local selection
India pa lil 46	...	...	...	...	local selection
Toma 112	...	...	...	...	local selection
Kalimodu 42	...	...	...	...	local selection
<i>Oryza barthii</i>	...	...	...	...	local wild rice

To French Guinea

Kavunginpoothala 12	...	...	...	...	local selection
Bolo 108	...	...	...	...	local selection
Ngasein 57	...	...	...	...	local selection
Toma 112	...	...	...	...	local selection
India pa lil 46	...	...	...	...	local selection
Indo-China 53	...	...	...	...	local selection, floating
Mbagboli	...	...	...	...	local, floating
Kema	...	...	...	...	local, resistant to submergence
Sughandi	...	...	...	...	ex Burma
Lead	...	...	...	...	ex British Guiana
D 99	...	...	...	...	ex British Guiana
B.G. 79	...	...	...	...	ex British Guiana

To Turkey

Bolo 108	...	...	...	...	local selection
Kavunginpoothala 12	...	...	...	...	local selection
Toma 112	...	...	...	...	local selection
D 99	...	...	...	...	ex British Guiana
Lead	...	...	...	...	ex British Guiana
B.G. 79	...	...	...	...	ex British Guiana
Sughandi	...	...	...	...	ex Burma

